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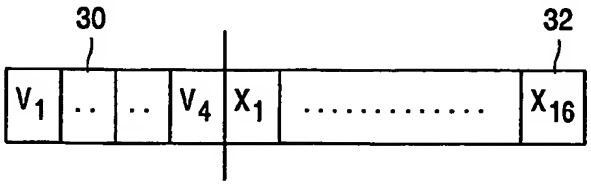
(54) Title: MOBILE STATION FOR RETRIEVING AN INFORMATION RELATED TO AN ASSOCIATION TREE



(57) Abstract: A mobile station for use in a telecommunication system is arranged to receive a signal from a base station. The signal comprises multiple communications, each communication of the multiple communications has first and second characteristics for enabling retrieval of a communication from the received signal. The mobile station is also arranged to receive a reference to said first and second characteristics which is used to obtain the first and said second characteristics.

MOBILE STATION FOR RETRIEVING AN INFORMATION RELATED TO AN ASSOCIATION TREE

This invention relates to a mobile station for use in a telecommunication system. The invention further relates to a base station for use in a telecommunication system and to a signal for transmission from a base station to a mobile station. The field of the invention are telecommunication systems such as UTRA-TDD and in particular use of advanced detection algorithms such as Joint Detection or Multi User Detection by mobile stations in such a telecommunication system. In fact, Joint Detection or Multi User Detection are generic names for algorithms such as ZF-BLE (Zero Forcing Block Linear Equalizer), PIC (Parallel Interference Cancellation), SIC (Successive Interference Cancellation).

European patent EP 1 137 201 A1 discloses a method for enabling a mobile station to use advanced detection algorithms, such as Joint Detection, that are normally implemented at the base station-side. To this end, a base station transmits a word representative of transmission parameters respectively allocated to the mobile stations in communication with that base station. It is disclosed that a selection unit is provided to select some midambles in relation with a word W. The word W has as many elements as the number of available midambles $m^{(i)}$ so that one element w_i of the word W corresponds univocally to one midamble $m^{(i)}$ .The first element corresponds to the first midamble, the second element corresponds to the second midamble and so on. All selected midambles are summed in a summation unit in order to form the general midamble of the Burst N. At a mobile station side, a correlation with a special sequence based on a basic midamble code (BMC) is performed which results in a received word W_r that is a representation of all selected midambles.

It is an object of the present invention to enable a mobile station to efficiently use an advanced detection algorithm. This object is according to the invention realized in that said mobile station is being arranged to receive a signal from a base station, the signal comprising multiple communications, each communication of said multiple communications

having a first characteristic and a second characteristic enabling retrieval of said communication from said signal, the mobile station further being arranged to receive a reference to said first and second characteristics and to obtain said first and said second characteristics through said reference. The invention is based on the insight that solely on the basis of available midamble codes advanced detection algorithms cannot be used in a mobile station in an efficient way.

In an embodiment of the present invention said first characteristic comprises a midamble code and said second characteristic comprises a spreading code. Herewith the mobile station does not have to rely on blind spreading code detection whereby the mobile station would have to correlate the received communication signal with all possible spreading codes.

According to another embodiment of the present invention, said reference to said first and second characteristics is a reference to an association tree for defining associations between said first and second characteristics. The relations between the first and second characteristic e.g. the midamble code and the spreading code are relations that are standardized by standardization committees such as 3GPP, the 3rd Generation Partnership Program for defining 3G communication systems. The relations are typically defined in the form of a tree, see e.g. Fig. B.2.1 on page 72 of 3GPP TS 25.221 V4.1.0. By providing information on said association tree, the mobile station does not only know which midamble codes may be used, but it also knows which spreading code or channelization code can be associated to that midamble code.

According to an embodiment of the present invention said reference to said association tree comprises a maximum number of mobile stations that can be communicating with said base station. The associations laid down in the association tree are used by the base station to code each communication of said multiple communications. There are however multiple association trees, each of which may be used by said base station. The choice for a specific tree depends on the number of midamble codes, i.e. said first characteristics, that are needed within the telecommunication system. Each mobile station is assigned a single and unique midamble code. Therefore, the number of midamble codes matches the number of mobile stations that can be in communication with said base station. For that reason, it is possible to determine the used association tree from the number of mobile stations that can be in communication with said base station.

According to an embodiment of the present invention said reference to said first and second characteristic, comprises a representation of a relation between said first

characteristic and said second characteristic. Although in many cases there may be a one-to-one relation between said first and second characteristics it is equally possible that said first characteristic is associated with multiple second characteristics i.e. multiple spreading codes. This is e.g. the case if a mobile station has a need for a higher transmission capacity. If a mobile station would have no additional information on the one-to-many relations between said first characteristic and said second characteristics, it would have to rely on blind code detection for detecting the second characteristics that are being used by said communications. By defining the relation between said first and said second characteristics for possible one-to-many relations only, blind code detection can be avoided whilst at the same only a limited amount of additional information has to be transmitted to the mobile station.

According to another embodiment of the present invention, said reference to said first characteristics comprises the actual number of mobile stations that are communicating with said base station. This parameter may serve as kind of a quality indicator since the number of mobile stations that are in communication with said base station must match the number of first characteristics since each communication of said multiple communications has only a single of said first characteristics assigned.

According to an embodiment of the present invention said reference to said first characteristic comprises a representation of said first characteristic. By providing a representation of the first characteristic, the mobile station can omit the intermediate step of first having to obtain the representation of said first characteristic by correlating the received signal with a basic midamble code. Therefore , this embodiment is more effective and less prone to errors particularly, if the propagating channels are suffering from degrading effects like multipath of flat Raleigh fading.

These and other aspects of the present invention will be elucidated further by means of the following drawings.

Fig. 1 shows a telecommunication system according to the present invention.

Fig. 2 shows a mobile station according to the present invention.

Fig. 3 shows an example of an association tree between midambles and spreading codes according to 3GPP TS 25.221 V4.1.0 (2001-06).

Fig. 4 shows a first embodiment of the coded word according to the present invention.

Fig. 5 shows a second embodiment of the coded word according to the present invention.

Fig. 6 shows a block diagram of a hybrid method to determine the used midambles and the association between the used spreading codes and the used midambles.

Fig. 1 shows a telecommunication system based on UTRA-TDD. Shown is a base station 10, which is in communication with mobile stations MS1, MS2 and MS3. Each mobile station receives an identical signal S1 that is transmitted by the base station. Although S1 comprises multiple communications intended for each of the mobile stations MS1, MS2 and MS3, a mobile station can only retrieve its own part of the information. For this purpose each mobile station is assigned a personal midamble code and at least one spreading code. In order to improve overall system performance, the mobile stations MS1, MS2 and MS3 might use advanced retrieval algorithm like Multi User Detection or Joint Detection. Typically, these algorithms are used by base station 10. This requires that the base station has to inform the mobile stations MS1, MS2 and MS3 about the active midamble codes and associated spreading codes.

Fig. 2 shows a mobile station 1, having an antenna 3 and means 5 for receipt of signal S1. The received signal S1 is coupled to means 7 for retrieving each communication from the multiple communications by means of an advanced detection algorithm that uses the first and second characteristics of each communication. Means 9 are arranged to receive a reference to the first and second characteristics from which means 11 can determine the first and second characteristics. Subsequently, means 11 provides the first and second characteristics to means 7 so that they can be used by the advanced detection algorithm.

Fig. 3 shows an example of an association tree that defines the relation between the midamble and the spreading code(s). The example is taken from the 3GPP technical specification TS 25.221 version V4.1.0 (2001-06). Fig. 3 is an association tree that can be used in case a maximum number of 14 mobile stations (K=14) can be in communication with the base station. It should be noted that in most cases there is a unique relation between midamble and spreading code. However, if a mobile station requires a higher transmission capacity, it can get a midamble assigned that can be associated with multiple spreading codes. In Fig. 3 for example, midamble $m^{(13)}$ can be associated with two spreading codes i.e. $c_{16}^{(14)}$, $c_{16}^{(13)}$ thereby doubling the transmission capacity if required.

Fig. 4 shows a first embodiment of a coded word according to the present invention. The coded word comprises two parts. Part I 30 defines the maximum number of mobile stations (K) that can be in communication with base station 10. By means of example, Part I 30 is four bits wide. The maximum number of mobile stations defines the association tree that is in use by the system. Once the association tree is identified, the relations that exist between midamble and spreading codes are known. Part II 32 defines the active midambles. There are as much active midambles as there are active mobile stations. X_i equals one, indicates that midamble $m^{(i)}$ is existing. As an example the second part is 16 bits wide. The remainder of the 16 bits, that are not used for the definition of the active midambles, are used to define the association between spreading code and midamble code in case this relation is ambiguous. For example, with K=16 (not shown here) there is no ambiguity since in this case, each midamble is associated with a single spreading code. With K=14 however, $m^{(13)}$ can be assigned to $c_{16}^{(14)}$ or to $c_{16}^{(14)}$ & $c_{16}^{(13)}$ and $m^{(14)}$ can be assigned to $c_{16}^{(16)}$ or to $c_{16}^{(16)}$ & $c_{16}^{(16)}$. By defining that X_{15} equals zero means that $m^{(13)}$ is assigned to $c_{16}^{(14)}$ and X_{15} equals one means that $c_{16}^{(14)}$ & $c_{16}^{(13)}$ are being assigned to $m^{(13)}$,the relation between midamble code and spreading code can unambiguously be defined. Equally, by defining that X_{16} equals zero means that $m^{(14)}$ is assigned to $c_{16}^{(16)}$ and X_{16} equals one means that $c_{16}^{(16)}$ & $c_{16}^{(15)}$ are assigned to $m^{(14)}$, the relation between $m^{(14)}$ and the corresponding midambles can also be unambiguously defined. Clearly associations for other K factors (maximum number of mobile stations) can be coded using the same strategy.

Fig. 5 shows a second embodiment according to the present invention. In this case the word comprises of three parts. Part I 40, defines the maximum number of mobile stations that may be in communication with the base station 10. Again this information is required to determine the association tree that is in use by the system. Part II 42 defines the number of mobile stations that is in communication with base station 10. Actually, this number might be less than the maximum number of mobile stations that can be in communication with base station 10. Part III 44 defines the relation between a midamble code and spreading codes in case this relation is ambiguous. For example with K=14 this could mean that if X_1 equals zero, $m^{(14)}$ is assigned to $c_{16}^{(16)}$ and if X_1 equals one , $c_{16}^{(16)}$ & $c_{16}^{(15)}$ are assigned to $m^{(14)}$. Likewise if X_2 equals zero, $m^{(13)}$ is assigned to $c_{16}^{(14)}$ and if X_1 equals one , $c_{16}^{(14)}$ & $c_{16}^{(13)}$ are assigned to $m^{(13)}$. The midambles however, would still have to be detected by correlating the received data with all midambles that are defined in the association tree. Clearly associations for other K factors (maximum number of mobile stations) can be coded using the same strategy.

Fig. 6 shows by means of example a midamble detection device for detecting the midambles and associated spreading codes for a coded word according to the second embodiment of the coded word. The received signal is processed by a baseband receiver 50. A first output of the baseband receiver is coupled to a info detection unit 52, this unit decodes the parts I, II and III of the coded word. Part I, which represents the maximum number of users (K) is coupled to the midamble generator 54 which is designed to generate K midambles. Each of the generated midambles is coupled to a first input of one of the midamble correlators. A second output of the baseband receiver is coupled to each of the midamble correlators 56 as well. The output of each of the correlators 56 is coupled to the selector. It has to be understood that a midamble correlator$_i$ for detecting midamble $m^{(i)}$ should only detect $m^{(i)}$ if this midamble is actually used. However, due to disturbing effects like multipath fading it might be possible that not in all cases the correct number of midambles can be detected. However, by passing information on the actual number of users (Part II) to selection unit 58, the actual midambles can reliably be determined. Mapping the midambles to the spreading codes is done by the association mapping 60. To this end, Part III of the coded word is coupled to an input of the application mapping 60.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. Mobile station for use in a telecommunication system, said mobile station being arranged to receive a signal from a base station, the signal comprising multiple communications, each communication of said multiple communications having a first characteristic and a second characteristic enabling retrieval of said communication from said signal, the mobile station further being arranged to receive a reference to said first and second characteristics and to obtain said first and said second characteristics through said reference.

2. Mobile station according to claim 1, wherein said first characteristic comprises a midamble code and said second characteristic comprises a spreading code.

3. Mobile station according to claim 1, wherein said reference to said first and second characteristics is a reference to an association tree for defining associations between said first and second characteristics.

4. Mobile station according to claim 3, wherein said reference to said association tree comprises a maximum number of mobile stations that can be communicating with said base station.

5. Mobile station according to claim 1, wherein said reference to said first and second characteristics comprises a representation of a relation between said first characteristic and said second characteristic.

6. Mobile station according to claim 1, wherein said reference to said first characteristic comprises the actual number of mobile stations that are communicating with said base station.

7. Mobile station according to claim 1, wherein said reference to said first characteristic comprises a representation of said first characteristic.

8. Mobile station according to claim 7, wherein said representation of said first characteristic comprises a binary word, each bit of said binary word indicating whether said first characteristic is used by said multiple communications.

9. Mobile station according to claim 1, wherein said reference to said first and second characteristics is transmitted in a channel.

10. Mobile station according to claim 9, wherein said channel is a broadcasting channel.

11. Mobile station according to claim 1, wherein said communication is retrieved from said multiple communications using a multi user detection algorithm.

12. Mobile station according to claim 1, wherein said communication is retrieved from said multiple communications using a joint detection algorithm.

13. Base station for use in a telecommunication system, said base station being arranged to transmit a signal to a mobile station, the signal comprising multiple communications, each communication of said multiple communications having a first characteristic and a second characteristic enabling retrieval of said communication from said signal, the base station further being arranged to transmit a reference to said first and second characteristics through which said first and said second characteristic can be obtained.

14. Signal for transmission from a base station to a mobile station, said signal comprising a reference to a first characteristic and a second characteristic, said first and second characteristic enabling said mobile station to retrieve a communication from received multiple communications and said reference enabling said mobile station to retrieve said first and second characteristics.

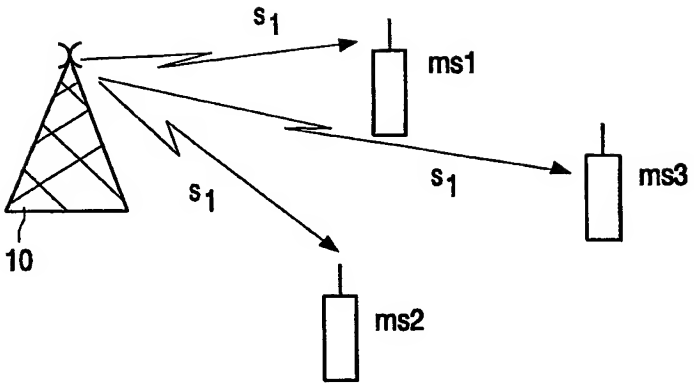


FIG. 1

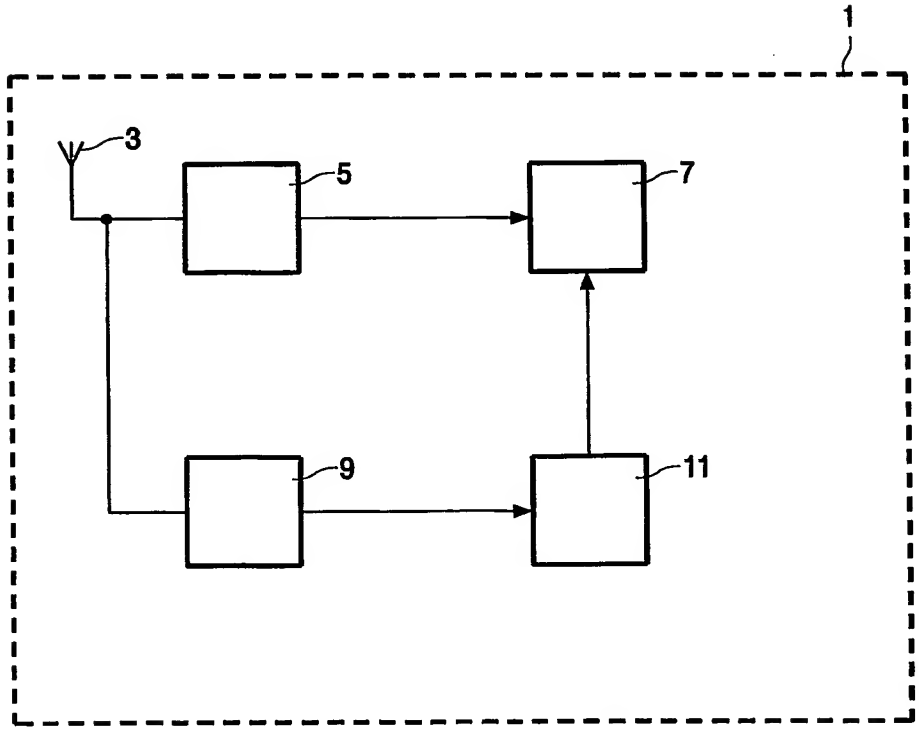


FIG. 2

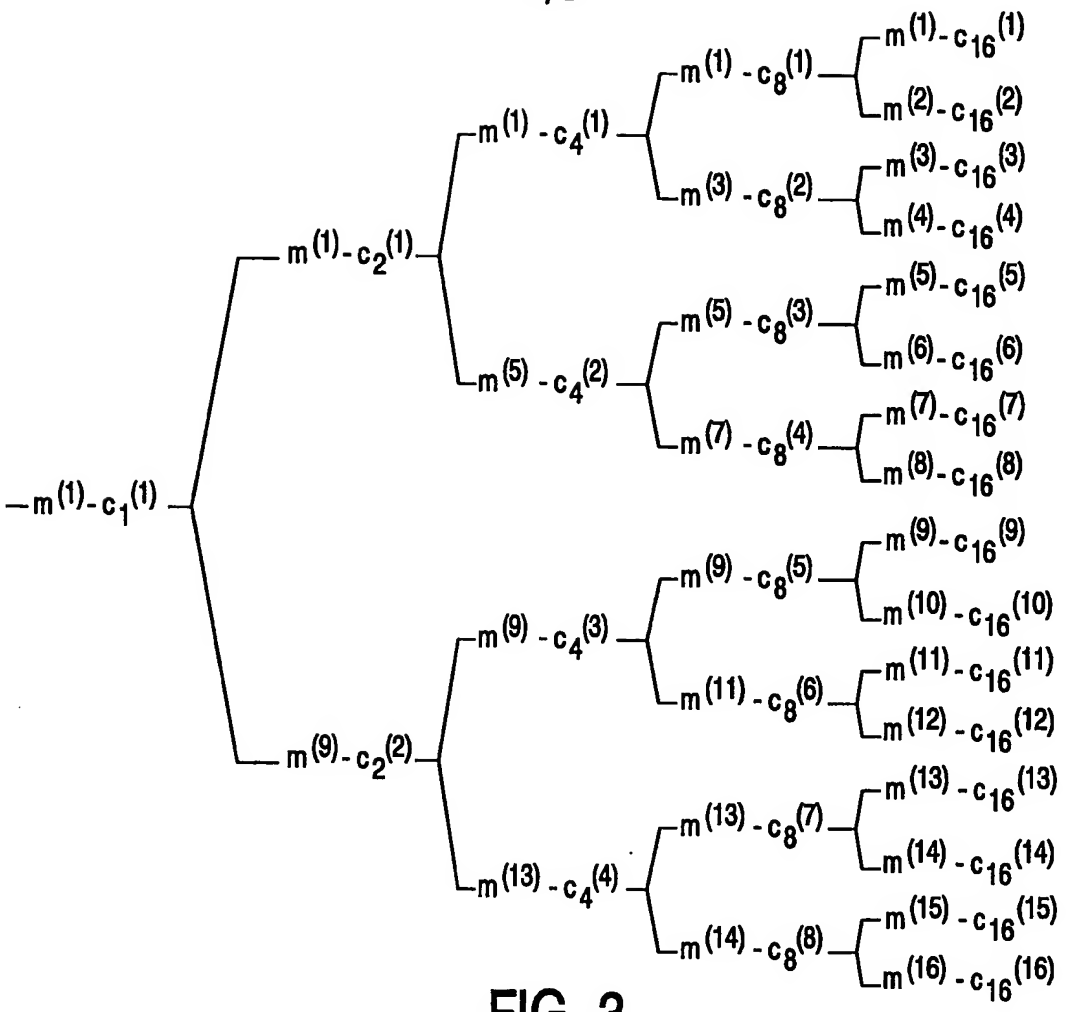


FIG. 3

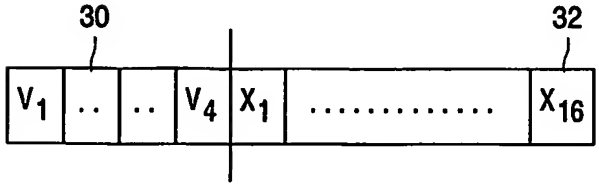


FIG. 4

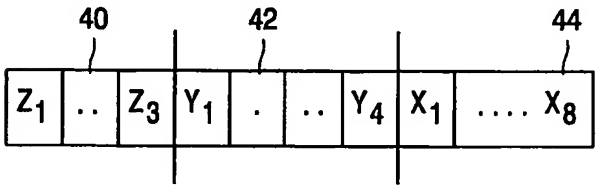


FIG. 5

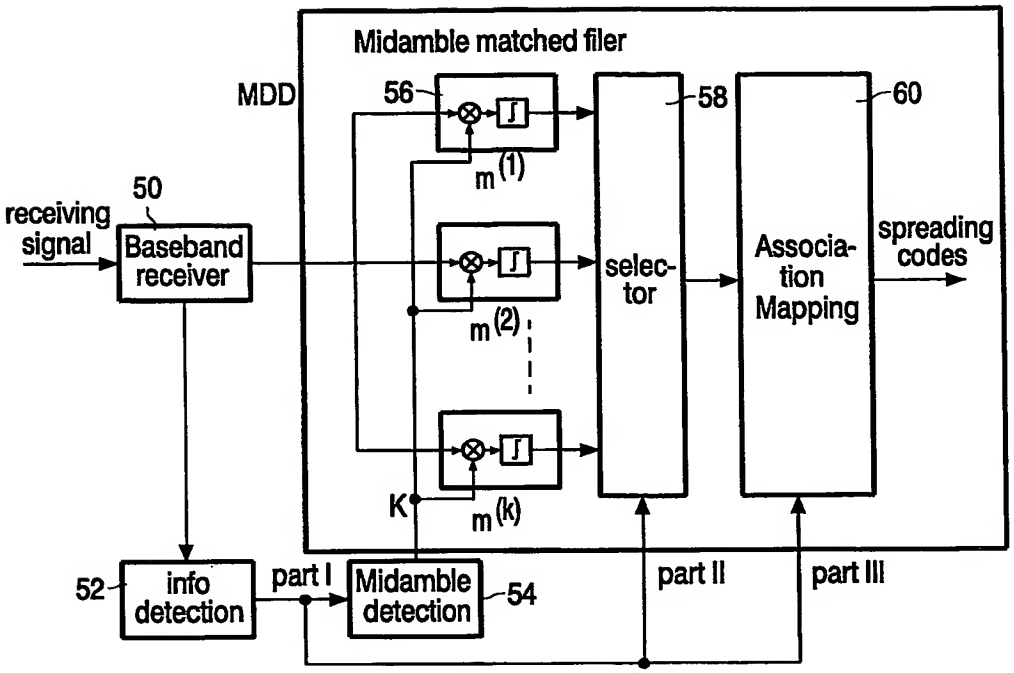

Midamble matched filer
MDD
56
58
60
m(1)
50
receiving signal
Baseband receiver
selec-tor
Associa-tion Mapping
spreading codes
m(2)
K
m(k)
52
info detection
part I
Midamble detection
54
part II
part III

FIG. 6

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 137 201 A (MITSUBISHI ELECTRIC INF TECH) 26 September 2001 (2001-09-26) paragraph '0036! - paragraph '0062!; figures 8-11	1-14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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EP 1137201 A	26-09-2001	EP 1137201 A1	26-09-2001
		AU 4117601 A	03-10-2001
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		EP 1414170 A1	28-04-2004
		WO 0172070 A1	27-09-2001
		US 2003224755 A1	04-12-2003
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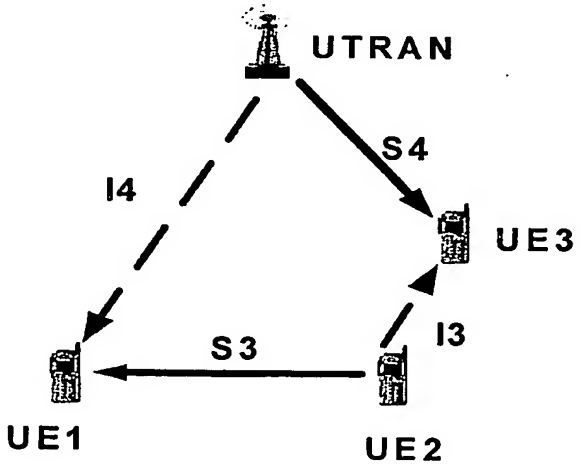
(54) Title: A METHOD AND APPARATUS FOR SUPPORTING P2P COMMUNICATION IN TDD CDMA COMMUNICATION SYSTEMS



(57) Abstract: A method for supporting P2P communication between two user equipments in TDD CDMA systems, performed by user equipment, comprising: receiving signals transferred via the downlink control channel from network system; acquiring the timeslot allocation information and the spreading code allocation information of other active user equipments allocated in the specific downlink timeslot associated with the direct link used by said user equipments, according to the received signals; and synchronizing the P2P communication signals received by the user equipment and signals from network system, according to the acquired timeslot allocation information and spreading code allocation information, so as to reduce the interference caused by the downlink signals transmitted from network system to other user equipments during the P2P communication process.

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A METHOD AND APPARATUS FOR SUPPORTING P2P COMMUNICATION IN TDD CDMA COMMUNICATION SYSTEMS

Field of the Invention

The present invention relates to a method and apparatus for supporting P2P communication in TDD CDMA (Time-Division-Duplex Code-Division-Multiple-Access) communication systems, and more particularly, to a method and apparatus for reducing interference caused by conventional communication signals to a UE (user equipment) during P2P communication process in TDD CDMA communication systems.

Background Art of the Invention

In conventional cellular mobile communication systems, a UE (user equipment) has to communicate with another UE only through the relaying of base stations even if the two UEs are very close to each other. Fig. 1 illustrates the conventional communication mode. However, in some cases when the distance between two UEs who camp on the same cell is very close, it can be a more reasonable way for them to communicate directly, rather than through the relaying of base stations. This method is the so-called peer-to-peer communication, abbr. as P2P.

Fig. 2 illustrates the P2P communication between two UEs. Referring to Fig. 2, assume that the two UEs are camping in the same cell and the distance between them satisfies the requirement for establishing P2P connection, the dashed line represents signaling link between the UTRAN and the UE during P2P communication, the solid line for data link between the two UEs, and the arrowhead for direction of information flow. It can be obviously seen from the figure that only signaling link exists between the UTRAN and the UE; while only data link exists between the two communicating UEs. If additional signal overhead for management is ignored, P2P communication can save about 50% radio resource during the process of direct link. Furthermore, control channels are reserved between the UTRAN and the UEs, so wireless network operators still holds control through the base station over how the UEs utilize radio resources.

It is commonly accepted that a Time Division Duplex (TDD) air interface is a communication standard that offers a more flexible adaptation to different uplink and downlink traffic requirements. Among existing 3G systems based on TDD communication mode, TD-SCDMA (Time Division – Synchronization Code Division Multiple Access) system is the most suitable system for the combination of P2P communication with conventional communication mode, because the same carrier frequency is applied in both uplink and downlink communications, which can simplify the RF (Radio Frequency) module of the mobile terminal.

In a TD-SCDMA system that is capable of employing P2P communication mode, the DIRECT mode is introduced to describe the direct communication between two UEs, besides two other working modes – IDLE mode and CONNECT mode defined in conventional TD-SCDMA system. The communication link in direct mode can be defined as FORWARD link (e.g.: the link from UE1 to UE2) and BACKWARD link (e.g.: the link from UE2 to UE1) identified according to the information flow direction for one UE to send signals to the other UE or receive signals from the other UE. Because P2P communication mode is constructed in combination with existing TD-SCDMA systems, the UTRAN, the P2P UEs and other conventional UEs allocated in the same timeslot can overhear the information transferred on the FORWARD link or BACKWARD link, i.e.: from the view of the UTRAN, even though the UEs have no connection with the UTRAN, the FORWARD link and BACKWARD link are associated with a certain uplink timeslot or downlink timeslot (the FORWARD link and BACKWARD link can correspond to different uplink timeslot or downlink timeslot depending on different resource allocation schemes). Hence P2P communication will cause signal interference to conventional communication. Similarly, two P2P UEs can also overhear the information transferred in the uplink timeslot or downlink timeslot associated with its FORWARD link or BACKWARD link during P2P communication. Therefore, when conventional links share the same timeslots with the P2P links, conventional uplink or downlink communication will interfere with the communication of the P2P FORWARD link or BACKWARD link, which seriously deteriorates the performance of P2P-enabled TDD CDMA communication systems.

To improve the performance of P2P-enabled TDD CDMA communication

systems, it's necessary to effectively reduce the signal interference caused by P2P communication mode to the TD-SCDMA communication systems.

First of all, analysis will go to the interference signal brought by introducing P2P communication mode in the following, and then how to reduce interference signal will be described. For simplicity in the following, the timeslot in which one UE transmits signals to the other UE through the above FORWARD link or BACKWARD link is called transmit timeslot (Tx timeslot), while the timeslot in which the UE receives signals from said another UE through the above FORWARD link or BACKWARD link is called receive timeslot (Rx timeslot), wherein the Tx timeslot or Rx timeslot is associated with an uplink timeslot or downlink timeslot in the sub-frame in conventional communication respectively.

1. Interference associated with uplink timeslot between P2P link and conventional link

Figure 3 illustrates the interferences between P2P link and conventional link in P2P-enabled TD-SCDMA systems when the P2P link is associated with uplink timeslot. As shown in Fig.3, it is assumed that UE1 and UE2 work in P2P mode and UE3 works in conventional mode, wherein UE1's Tx timeslot is associated with UE3's uplink timeslot, that is, UE1 and UE3 are allocated in the same uplink timeslot to transmit signals respectively to UE2 and the UTRAN. S1 is the information from UE1 to UE2 through direct link (taken as FORWARD link) and S2 is uplink information from UE3 to the UTRAN through uplink, moreover, S1 and S2 are associated with the same uplink timeslot but with different spreading codes.

In TD-SCDMA communication systems, one of the most important features is to maintain uplink synchronization, which means signals from different UEs should arrive at the UTRAN at the same time to guarantee the orthogonality of the spreading codes of signals from the main paths of different UEs.

For conventional communication systems, the UTRAN monitors and controls the UEs' uplink transmitting timing via a specific traffic burst structure in CONNECT mode so as to maintain uplink synchronization for each UE. But for P2P communication mode , the UTRAN is only involved in P2P link establishment procedure and not involved in the P2P communication procedure after P2P link's establishment. Therefore, during P2P communication, there is no dedicated

channel between the UTRAN and the two P2P UEs, so the UTRAN cannot adjust the uplink synchronization advance for the two P2P UEs transmitting signals by using specific traffic burst to maintain uplink synchronization even if it can overhear and estimate the uplink synchronization shift of the two P2P UEs.

Referring to Fig. 3, when UE1 and UE3 transmit signals in the same uplink timeslot, the UTRAN can overhear information S1 transferred from UE1 to UE2 (to the UTRAN, S1 is considered as interference signal I1). But as described above, there is no dedicated channel between the UTRAN and UE1, so the UTRAN can't adjust UE1's transmission timing by using the traffic burst in conventional communication mode even if it can overhear information S1 and estimate UE1's synchronization shift information, which means UE1 working in P2P mode may lose uplink synchronization with the UTRAN (UE3 working in conventional mode can maintain uplink synchronization with the UTRAN with conventional mode). That is, I1 and S2 are likely to reach the UTRAN unsynchronously, which will potentially impair uplink synchronization and thus degrade the system performance.

Similarly, when UE1 and UE3 transmit signals in the same allocated uplink timeslot, UE2 can also overhear signal S2 transferred from UE3 to the UTRAN (to UE2, S2 is considered as interference I2), and interference signal I2 will also produce impact on UE2's receiving S1, which may potentially impair the P2P communication quality.

2. Interference associated with downlink timeslot between P2P link and conventional link

Figure 4 illustrates the interferences between P2P link and conventional link in a P2P-enabled TD-SCDMA system when the P2P link is associated with downlink timeslot. It is assumed that UE1 and UE2 work in P2P mode and UE3 works in conventional mode, wherein UE1's Rx timeslot is associated with UE3's downlink timeslot, that is: UE1 and UE3 are allocated in the same downlink timeslot to respectively receive signals from UE2 and the UTRAN. S3 is the P2P link information from UE2 to UE1 via direct link (taken as BACKWARD link) and S4 is downlink information from the UTRAN to UE3 via downlink, furthermore, S3 and S4 are associated with the same uplink timeslot but with different spreading codes.

In Fig. 4, the downlink information S4 transmitted from the UTRAN to UE3 may produce interference to other UEs who share the same downlink timeslot with UE3 but use different spreading codes to receive signals. Such interference is called multi-access interference (MAI).

Referring to Fig. 4, when UE1 and UE3 receive signals in the same allocated downlink timeslot, UE1 can overhear information S4 transferred from the UTRAN to UE3 via downlink (to UE1, S4 is considered as interference signal I4), and generally the transmission power of signals from the UTRAN is relatively strong, so the interference signal I4 is likely to impair the direct communication quality seriously.

Similarly, when UE1 and UE3 receive signals in the same allocated downlink timeslot, UE3 can also overhear information S3 transferred from UE2 to UE1 (to UE3, S3 is considered as interference signal I3, and meanwhile UE2 can be taken as the pseudo-UTRAN of transmission information in downlink timeslot), and the interference signal I3 will impair the communication quality of UE3 near UE2 and other UEs in the same timeslot as UE3 to receive signals.

3. Interference between P2P direct link pairs

Figure 5 illustrates the interferences between two P2P direct link pairs in a P2P-enabled TD-SCDMA system, wherein a UE in one of the two P2P link pairs receive transmit signals to another UE in another P2P link pair. Assume that UE1 and UE2 work in one P2P link pair while UE3 and UE4 in another P2P link pair.

Because the P2P link pairs are symmetrical, in the associated timeslot, signal S5 or S6 from UE1 to UE2 will become interference I5 or I6 to UE4 who is receiving signals from UE3. Obviously these interferences may also greatly impair the direct communication quality.

As noted above, after P2P link is introduced in conventional TD-SCDMA systems, there exist 6 possible interference signals I1, I2, I3, I4, I5 and I6. Depending on whether the UTRAN is involved, the above 6 interference signals can be divided into two types. The first type includes interferences between the UEs, such as I2, I3, I5, and I6; and the second type includes the interferences with UTRAN involved, such as I1 and I4.

To guarantee the communication quality of a P2P-enable TD-SCDMA

communication system, effective methods needs to be researched to cancel the above 6 interferences (it's better to achieve that without changing the physical layer structure of existing communication systems). Among the above 6 interference signals, the first type can be reduced or cancelled by efficiently limiting the radio range supported by P2P and adopting intelligent radio resource control scheme, while interference signal I1 can be cancelled as described in a patent application entitled "A Method and Apparatus for Uplink Synchronization Maintenance with P2P Communication in Wireless Communication Networks," filed by KONINKLIJKE PHILIPS ELECTRONICS N.V., on March 7, 2003, Attorney's Docket No. CN030004, Application Serial No. 03119894.5, the disclosures of which are hereby incorporated by reference. As for interference signal I4 of the second type, there is no effective solution yet now.

From the foregoing interference analysis, it can be seen that interference signal I4 is introduced by the UTRAN's transmitting signals to UE3 via the downlink to UE1 in the same downlink timeslot as UE3. Usually, the signal transmission power of the UTRAN is relatively strong enough that all UEs sharing the same downlink timeslot in the same cell can overhear the signal transmitted, and moreover the signal is the mixed one including redundant information of many other UEs, hence, I4 can't be ignored. In UE1, UE1 must adopt MUD (multi-user detection) or JD (joint detection) to cancel the interference signal, so as to guarantee the direct communication quality.

Summary of the Invention

The object of the present invention is to provide a method and apparatus for supporting P2P communication in TDD CDMA communication systems, so as to reduce interferences to the UE caused by downlink signal from conventional communication transmitted in the same downlink timeslot as the UE during direct communication.

To achieve the above object, a method for supporting a UE to perform P2P communication in TDD CDMA communication systems in accordance with the present invention, comprising: receiving signals transferred by network system via downlink control channel; acquiring the timeslot allocation information according to

the received signals; acquiring the spreading code allocation information of other active UEs allocated in the specific downlink timeslot associated with the direct link used by the UE, according to the signals transferred via downlink control channel; and reducing the interference to the UE caused by downlink signals in conventional communication during P2P communication, according to the acquired timeslot allocation information and spreading code allocation information.

A method for supporting P2P communication between two UEs , performed by network system, in TDD CDMA communication systems in accordance with the present invention, comprising: sending the timeslot allocation information to the two P2P UEs via downlink control channel; generating spreading code allocation information corresponding to each downlink timeslot in said timeslot allocation information; and sending the said spreading code allocation information to these two UEs respectively so as to synchronize the P2P communication signal of each of the two UEs with the signals from network system .

Brief Description of the Accompanying Drawings

Fig. 1 is a schematic diagram illustrating two UEs communicate through the relaying of base stations in conventional communication mode;

Fig. 2 is a schematic diagram illustrating the P2P communication mode between two UEs;

Fig. 3 is a schematic diagram illustrating the generation of interference signals between direct link and conventional link employing uplink timeslot to communicate, in a P2P-enabled TD-SCDMA system;

Fig. 4 is a schematic diagram illustrating the generation of interference signals between direct link and conventional link employing downlink timeslot to communicate, in a P2P-enabled TD-SCDMA system;

Fig. 5 is a schematic diagram illustrating the generation of interference signals between two direct link pairs in a P2P-enabled TD-SCDMA system;

Fig. 6 is a schematic diagram illustrating the timeslot allocation information in accordance with the present invention;

Fig. 7 is a schematic diagram illustrating the spreading code allocation information in accordance with the present invention;

Fig. 8 is a schematic diagram illustrating the time relationship between receiving downlink signals from the UTRAN and that from UE2 respectively at UE2 and UE1 with the UTRAN as the time benchmark when downlink timeslot is employed to communicate;

Fig. 9 is a schematic diagram illustrating the method to be performed in the present invention for downlink synchronization for an Rx UE in direct mode.

Detailed Description of the Invention

According to the analysis to interference signals in a P2P-enabled TD-SCDMA communication system as above, the present invention primarily focuses on addressing the problem of interference signals from conventional downlink for a Rx UE in P2P communication.

In fact, an advanced receiver has been widely used in the UTRAN of TD-SCDMA communication systems, i.e. using MUD or JD method to cancel MAI interference, as disclosed in detail in the article entitled "Multi-user Detection for DS-CDMA Communication," written by S.Moshavi, in *IEEE Commun. Mag.*,Oct.1996, page 124-136, and the article entitled "Zero forcing and minimum mean-square-error equalization for multiuser detection in code division multiple access channels," written by A. Kelein, G. K. Kaleh, in *IEEE Trans. Vehicular Tech.*,Vol.45, No.2, May 1996, pp 276-287, the disclosures of which are hereby incorporated by reference. But to apply interference canceling method like MUD or JD in the receiver of a UE, two conditions needs to be satisfied in advance:

1. acquire the spreading code information of all active UEs allocated in the same timeslot as the UE;

2. when receiving signals from direct link, the UE in direct mode should maintain synchronization with associated downlink signals from the UTRAN (the complexity of implementing the receiver can be effectively simplified only with signal synchronization).

Discussions will respectively be given below to the above two conditions:

1. How to obtain spreading code allocation information

In a TD-SCDMA communication system taken as an example, the spreading codes used by all active UEs are controlled by the base station subsystem

UTRAN. During communication, RF signals convey information in form of frame. Every RF frame is divided into two sub-frames, and every sub-frame has 7 timeslots. Each UE allocated in the same timeslot transmits or receives signals using different spreading code allocated by the base station subsystem. Downlink control channel such as BCCH (Broadcast Control CHannel), has fixed position in each radio frame or sub-frame, and a UE can receive information from downlink control channel no matter working in conventional mode or P2P mode, so the UE can obtain the spreading code allocation information of all UEs sharing the same timeslot, according to the control information transferred from the UTRAN via downlink control channel.

Wherein spreading code allocation information includes two parts: (i) the timeslot allocation information in each frame or sub-frame about whether each timeslot is to be used in uplink or downlink; (ii) the spreading code allocation information associated with each allocated downlink timeslot.

In the embodiments of the present invention, the above timeslot allocation information and spreading code allocation information respectively store the involved information into the corresponding timeslot allocation map and spreading code allocation map through mapping, especially:

(1) About the timeslot allocation information

In a TD-SCDMA communication system taken as an example, each sub-frame has 7 timeslots, denoted as TS0-TS6, so an octet with 8 bits can be used to map the 7 timeslots in a sub-frame in timeslot allocation map.

Wherein a timeslot corresponds to a bit in the octet. As Fig. 6 shows, TS0-TS6 respectively corresponds to Bit6-Bit0 in the octet, while Bit7 is reserved. For each bit in Bit6-Bit0, assume that its corresponding timeslot is to be used as downlink timeslot when it is 1, and as uplink timeslot when it is 0. In TD-SCDMA systems, TS0 is always allocated as downlink and TS1 as uplink, so let Bit6=1 and Bit5=0.

(2) About the spreading code allocation information associated with each allocated downlink timeslot

After the timeslots in an RF frame or sub-frame are allocated, the UTRAN can accordingly generates the spreading code allocation information associated with

each associated downlink timeslot according to the downlink timeslots included in the sub-frame. A TD-SCDMA system is also taken as an example in the following.

In this communication system, a downlink timeslot may have totally up to 16 spreading codes for different UEs or different codes in one UE to use. So 16 bits are needed to represent how each spreading code in a downlink timeslot is used, that is, two octets are needed to represent the spreading code allocation information. It can be leant from the foregoing description that TS1 is always used as uplink in the 7 timeslots included in each sub-frame, therefore at most 6 timeslots in each sub-frame can be used as downlink, thus totally 12 octets are needed to represent how the spreading codes of the 6 timeslot are used.

The following embodiment will describe the spreading code allocation information included in a downlink timeslot. Assume that Bit4=0 and Bit1=0 in the timeslot allocation map shown in Fig. 6, that is, TS2 and TS5 are used as downlink timeslots, 4 octets are required to be included in the spreading code allocation map that corresponds to Fig. 7. Wherein the first two octets correspond to the allocation information of each spreading code in TS2 and the second two octets correspond to that in TS5. The part with lighter background color indicates the first two octets, wherein Bit15~Bit0 respectively correspond to the information about spreading codes Code15~Code0 in TS2 to be used by 16 UEs or codes at most; while the part with deeper background color indicates the second tow octets, wherein Bit15~Bit0 respectively correspond to the information about spreading codes Code15~Code0 in TS5 to be used by 16 UEs or codes at most. To each bit of the four octets in the above two groups corresponding to each spreading code, it can be defined as: when the bit corresponding to the spreading code is 1, it represents that the spreading code is used by a UE in the corresponding timeslot; when the bit corresponding to the spreading code is 0, it represents that the spreading code is not allocated to any UE in the corresponding timeslot yet. For instance, when Bit8 and Bit0 of the two octets in the first group are 1 while other bits are all 0, it represents only the spreading codes corresponding to Bit8 and Bit0 are occupied in TS2 corresponding to the first group, while other spreading codes are not allocated to any UE yet.

As described above, through mapping the allocation information of each timeslot in the sub-frame and the allocation information of each spreading code included in each downlink timeslot in the sub-frame into the timeslot allocation map and spreading code allocation map, the UTRAN can send the information included in the timeslot allocation map and spreading code allocation map to each UE via downlink control channel, so that the UE can obtain the timeslot allocation information and the spreading code allocation information associated with downlink timeslot.

Of course, the UE can also obtain the timeslot allocation information and the spreading code allocation information associated with uplink timeslot in a similar way, if needed.

2. Maintain synchronization with associated downlink signals from the UTRAN when a UE in direct mode is receiving signals from direct link

In conventional TD-SCDMA systems, the downlink mixed signals transmitted by the UTRAN should reach the UE synchronously if the multi-path delay effect is ignored. But in a P2P-enabled TD-SCDMA system, there is great difference between the transmission path of the useful signal S3 from a P2P UE and that of the interference signal I4 from the UTRAN (referring to Fig. 4), so their arriving time may be quite different, i.e.: when UE1 in direct mode is receiving signal S3 over direct link, it can't be guaranteed to keep synchronization with downlink signal I4 from the UTRAN. In this case, S3 and I4 can't arrive at UE1 at the same time, so the complexity of implementing channel estimation or JD (joint detection) will be increased greatly due to time unsynchronization although conventional JD method can still be employed to cancel interference signal I4 in UE1, even if UE1 can obtain the timeslot allocation information and spreading code allocation information transmitted by the UTRAN via downlink control channel.

To greatly simplify the operation of the receiver in UE1 and effectively cancel downlink interference signal I4, how to implement synchronization between direct link signal S3 and interference signal I4 at Rx UE1, arises as an important step to guarantee P2P communication quality.

As Fig. 4 shown, in the case that the useful signal S3 and interference signal I4 can't arrive at UE1 synchronously, there are two methods for them to arrive at

UE1 synchronously: the first is to adjust the TA for the UTRAN to transmit signal I4 so that signal I4 transmitted by the UTRAN and signal S3 transmitted by UE2 can arrive at UE1 synchronously; the second is to adjust the TA for UE2 to transmit signal S3 so that signal S3 transmitted by UE2 and signal I4 transmitted by the UTRAN can arrive at UE1 synchronously. Wherein it's impossible to realize the first method by adjusting the UTRAN's transmission TA for I4 and S3 to arrive at UE1 synchronously, because there are usually several P2P link pairs using the same downlink timeslot during communication process, which can't guarantee downlink interference signal I4 to be synchronized with signals (e.g. S3) received by the UEs in P2P communication just by adjusting a common transmission TA for the UTRAN to transmit signals. So, the TA adjustment must be done at UE2 for transmitting useful signal S3 to guarantee that each UE in direct mode can maintain synchronization with the associated downlink signals from the UTRAN when receiving signals from different direct links.

Before describing the above synchronization procedure in conjunction with Fig. 8, two issues need to be clarified in advance:

(i) Establish and maintain synchronization with the UTRAN in conventional communication mode

During cell search phase, each UE firstly establishes downlink synchronization with the UTRAN in conventional way, and then maintains downlink synchronization with the UTRAN by tracking the pilot channel in the sub-frame and taking the detected pilot channel as the time reference in its sub-frame.

(ii) Maintain synchronization with associated downlink timeslots in P2P communication mode

When UE1 and UE2 are in P2P direct mode, there is a dedicated channel between them, and the traffic burst structure of the dedicated channel is the same as that in conventional TD-SCDMA communication systems, which means that the power control information and synchronization shift information are also included in the traffic bursts of FORWARD link and BACKWARD link in the P2P dedicated channel. In conventional TD-SCDMA communication systems, the synchronization shift information included in traffic burst can be used to maintain uplink synchronization at the UTRAN, similarly the synchronization shift information

included in traffic burst of direct link can be used by the P2P UEs to maintain synchronization with associated conventional downlink when receiving direct link signals in P2P communication.

From the above clarification it can be seen that each UE respectively establishes downlink synchronization with the UTRAN in conventional way at the beginning of communication establishment (cell search phase), so two UEs can have a common time benchmark when establishing P2P communication, to determine synchronization between direct link signals and downlink signals. Meanwhile, the traffic burst of P2P dedicated channel contains the same synchronization shift information as in conventional mode, so the UE can set and adjust its signal transmission TA by using the synchronization shift information during P2P establishment and communication procedure, to guarantee synchronization between direct link signals and downlink signals.

Descriptions will be given below to synchronization procedure between direct link signals and downlink signals at the Rx UE, in conjunction with Fig. 8 and Fig. 4, wherein for UE1 the useful signal S3 and interference signal I4 share the same downlink timeslot.

First, taking the UTRAN as the common benchmark, the time relationship between the receiving time for each UE to receive signals and the common benchmark at the UTRAN is illustrated in Fig. 8. T0 is the downlink transmitting time benchmark in the associated downlink timeslot at the UTRAN, T1 and T2 are the related receiving time points at UE1 and UE2 respectively. UE1 and UE2 can identify T1 and T2 by finding and tracking the pilot channel from the UTRAN as described above. The durations $T_{UTRAN-UE2}$ (equal to T2-T0) and $T_{UTRAN-UE1}$ (equal to T1-T0) are signal transmission time from the UTRAN to UE1 and UE2 respectively. $T_{UE2-UE1}$ (equal to T21-T2) is signal transmission time from UE2 to UE1, provided that UE2 sends signal to UE1 at T2 and the signal arrives at UE1 at T21, wherein T21 should overlap with T1 so as to guarantee the useful signal S3 and interference signal I4 can arrive at UE1 at the same time.

Then, UE1 estimates the TA by estimating the channel impulse response of each midamble transmitted by UE2, and includes the estimated TA as synchronization shift information in the traffic burst from UE1 to UE2. The traffic

burst contains the midamble to be used for estimating the TA, so UE1 and UE2 can estimate and adjust signal transmission TA any time, even if the two UEs are both in mobility.

The above conventional downlink synchronization procedure addressing direct link can be summarized as follows:

(1) UE1 and UE2 establish and maintain downlink synchronization with the UTRAN respectively

UE1 and UE2 establish downlink synchronization during cell search, and maintain downlink synchronization by tracking the pilot channel (step 1).

(2) UE2 determines its transmitting time

UE2 sets time T2 as its transmitting time for transmitting signals to UE1 in associated downlink timeslot during direct link establishment procedure (step 2).

(3) UE1 measures the time difference between direct link signal and downlink signal

During direct link establishment procedure, when receiving the traffic burst transmitted by UE2 at T2, UE1 measures the time difference of $T_{UTRAN-UE2}+T_{UE2-UE1}-T_{UTRAN-UE1}$ (T21-T1) according to the midamble information contained in the traffic burst, and transmits the measurement result as feedback information to UE2 (step 3).

(4) UE2 sets its transmission TA

UE2 sets its transmission TA according to the feedback information from UE1 and adjusts its time to transmit signals according to this TA (step 4).

(5) UE1 estimates and sends synchronization shift information to UE2

UE1 estimates the synchronization shift information by evaluating the channel impulse response of each midamble from UE2 and sets the synchronization shift information in the traffic burst to be transmitted from UE1 to UE2 (step 5).

(6) UE2 adjusts its transmission TA

UE2 adjusts its transmission TA according to the synchronization shift information included in the traffic burst from UE1 (step 6).

(7) Iterate step 5 and step 6

Judge whether P2P communication is ended (step 7). If the direct communication is not ended yet, the above step 5 and step 6 will be iterated

continuously to keep direct link signal S3 to be synchronized with the associated downlink signal I4, so long as the direct link still shares the same timeslot as the downlink timeslot.

Through the above steps, the useful signal S3 from UE2 and interference signal I4 from the UTRAN can arrive at UE1 at the same time, to guarantee that UE1 can use MUD or JD algorithms to cancel downlink interference signal I4 and then to guarantee the performance of P2P-enabled TDD CDMA systems, with downlink synchronization and the acquired spreading code allocation information.

Of course, in the case when two UEs in direct communication mode are very close to each other, i.e.: when the receiving time points T1 and T2 are nearly equal, the time difference between direct link signal S3 and downlink signal I4 arriving at UE1 can almost be ignored. At this time, the above synchronization procedure can be omitted, and only spreading code allocation information is needed. UE1 can cancel the negative effect caused by interference signal I4 through JD.

Moreover, it should be noted that setting and adjusting the transmission TA by UE2 can only guarantee that the useful signal S3 and interference signal I4 arrive at UE1 at the same time, but can't guarantee that the useful signal S4 and interference signal I3 in Fig. 4 arrive at UE3 at the same time, thus UE3's receiver can't effectively cancel the effect caused by interference signal I3 in UE3 (or cancel I3's effect based on increasing complexity by using asynchronous JD method) according to the acquired spreading code allocation information. Fortunately, in practical communications, when UE3 extracts the desired information from S4 by using conventional synchronous JD method, its most interferences are from the received mixed signal S4, and interference signal I3's effect to the useful signal S4 can be ignored at this time.

The above method for supporting P2P communication in downlink timeslot in TD-SCDMA systems as proposed in the present invention, can be implemented in computer software, or hardware, or in combination of both software and hardware.

Beneficial Results of the Invention

As described above, referring to the method and apparatus for supporting

P2P communication in TD-SCDMA systems provided in the present invention, a UE in direct communication mode can acquire spreading code allocation information via downlink, thus the UE can effectively cancel the interference caused by the downlink signals transferred in the same timeslot in conventional communication, by utilizing the spreading code allocation information used by other UEs allocated in the same downlink timeslot, with methods like MUD or JD.

Furthermore, referring to the method and apparatus for supporting P2P communication in TD-SCDMA systems provided in the present invention, some steps are adopted to keep direct link signals and downlink signals in the associated timeslot synchronized, which greatly simplifies the operation of the UE to cancel downlink signal interference according to the spreading code allocation information, and simplifies the hardware setting of the UE's receiver.

Although the method and apparatus for supporting P2P communication in TD-SCDMA systems provided in the invention has been shown and described with respect to exemplary embodiments of TD-SCDMA, it should be understood by those skilled in the art that the communication method and apparatus are not limited hereof, but also suitable to other TDD CDMA systems.

It is also to be understood by those skilled in the art that the method and apparatus for supporting P2P communication in TD-SCDMA systems disclosed in this invention can be modified considerably without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A method for supporting P2P (Peer to Peer) communication between two user equipments in TDD CDMA systems, performed by user equipment, comprising:

receiving signals transferred via the downlink control channel by network system;

acquiring the timeslot allocation information according to the received signals;

acquiring the spreading code allocation information of other active user equipments allocated in the specific downlink timeslot associated with the direct link used by said user equipments, according to the received signals; and

reducing the interference caused by signals transferred via downlink from network system to said other user equipments during P2P communication according to the acquired timeslot allocation information and spreading code allocation information.

2. The communication method according to claim 1, wherein said spreading code allocation information at least includes the said spreading code information being used by other user equipments in said downlink timeslot.

3. The communication method according to claim 1 or 2, wherein said step of reducing the interference includes executing at least one of the methods Multi-User Detection (MUD) and Joint Detection (JD).

4. The communication method according to claim 3, wherein at least one of said methods Multi-User Detection (MUD) and Joint Detection (JD) utilizes said spreading code information being used by other user equipments in said downlink timeslot to reduce interference.

5. The communication method according to claim 4, further comprising:

establishing downlink synchronization with network system at the cell search phase, and keeping downlink synchronization with network system by tracking the pilot channel;

In said downlink timeslot, when said user equipments transmitting signals via said direct link, the steps taken by said user equipment comprises:

(i) during establishing said direct link, setting the time of transmitting signals to the other user equipment in said downlink timeslot, according to the received time of transmitting signals by network system;

(ii) transmitting test signals to the other user equipment at said set time in said downlink timeslot;

(iii) receiving feedback signal from the other user equipment, which is the time difference obtained by comparing the time at which the other user equipment receives the test signals and the received time at which the network system transmits signals in the other user equipment, after the other user equipment receiving said test signals;

(iv) setting the time advance for transmitting signals to the other user equipment according to the feedback signals; and

(v) adjusting the time at which the user equipment transmits signals to the other user equipment according to time advance, in order that the signals of downlink from network system, which are received by the other user equipment, are synchronized with the signals of said direct link from the user equipment.

6. The communication method according to claim 5, further includes:

(vi) transmitting the P2P communication signals to said the other user equipment at said adjusted time for transmitting;

(vii) receiving the synchronization shift information from said the other user equipment, which is the synchronization derivation estimated according to received the P2P communication signals in said the other user equipment after receiving said P2P communication signals; and

(viii) adjusting the timing advance for transmitting signals to the other user equipment according to the synchronization shift information.

7. The communication method according to claim 5 or 6, further includes:

adjusting the time at which the user equipment transmits signals to the other user equipment during the P2P communication procedure, according to the synchronization shift information from the other user equipment, in order that the P2P communication signals transmitted by the user equipment and the downlink signals transmitted by network system can reach the other user equipment at the same time.

8. The communication method according to claim 5,6 or 7 wherein when the user equipment receives signals via said direct link in said downlink timeslot, the step to be taken includes:

(a) calculating the difference between the time for receiving the test signals transmitted from the other user equipment and the time for receiving the signals transmitted from network system, and sends the calculated time difference as feedback signals to the other user equipment, when receiving test signals transmitted by said the other user equipment, during the process of establishing said direct link.

9. The communication method according to claim 8, wherein when the user equipment receives signals via said direct link in said downlink timeslot, the step to be taken further includes:

(b) estimating the synchronization shift information of the other user equipment according to the received P2P communication signals when the UE receives the P2P communication signals transmitted by the other user equipment, and sending the estimated synchronization shift information to the other one, during the process of establishing the said direct link.

10. The communication method according to claim 8 or 9, further includes:

calculating the synchronization shift information of the other user equipment according to the received P2P communication signals from said the other user equipment, and sending the synchronization shift information to the other one, during the process of P2P communication.

11. A method for supporting P2P communication between two user equipments in TDD CDMA systems, the steps taken by network system comprising:

sending the timeslot allocation information to the two users equipment conducting P2P communication via downlink control channel;

generating spreading code allocation information corresponding to each downlink timeslot of timeslot allocation information; and

sending said spreading code allocation information to the two user equipments via downlink control channel respectively, in order to synchronize the P2P communication signals received by each of the two UE with the signals from network system.

12. The communication method according to claim 11, wherein said spreading code allocation information at least includes spreading code information being used by other user equipments in said downlink timeslot.

13. A user equipment for supporting P2P (Peer to Peer) communication in TDD CDMA systems, comprising:

a signal transceiver, for receiving and transmitting radio signals;

a timeslot allocation information acquiring means for acquiring the timeslot allocation information according to the information transferred via downlink control channel;

a spreading code allocation information acquiring means for acquiring the spreading code allocation information of other active user equipments in a specific downlink timeslot which is used when the UE is receiving signals via the direct link between the UE and the other one, according to the information transferred via downlink control channel; and

a interference reducing means for reducing the interference caused by downlink signals transmitted from network system to other user equipments during P2P communication process according to the acquired timeslot allocation information and spreading code allocation information.

14. The user equipment according to claim 13, wherein said spreading code allocation information at least includes the spreading code information being used by other user equipments in said downlink timeslot.

15. The user equipment according to claim 13 or 14, wherein said interference reducing means executes at least one of the methods Multi-User Detection (MUD) and Joint Detection (JD) to reduce interference.

16. The user equipment according to claim 15, wherein one of said methods Multi-User Detection (MUD) and Joint Detection (JD) reduce interference by using said spreading code information being used by other user equipments in said downlink timeslot.

17. The user equipment according to claim 16, further including:

a synchronization means, for establishing downlink synchronization with network system at the cell search phase, and keeping downlink synchronization with the network system by tracking the pilot channel;

a transmitting time setting means, for setting the time for transmitting signals to the other user equipment in said downlink timeslot , according to the time for receiving the transmitting signals from the network system, in the process of establishing the said direct link;

a test signals transmitting means, for transmitting test signals to the other user equipment at the set time in said downlink timeslot;

a feedback signal receiving means, for receiving feedback signals from the other user equipment, which is the time difference obtained by comparing the time for receiving test signals and the time for receiving the transmitting signals from the network system in the other user equipment, after the other user equipment receiving the test signals;

a time advance setting means for setting the time advance for transmitting signals to the other user equipment; and

a transmitting time adjusting means based on said feedback signals, for adjusting the transmitting time at which the user equipment transmits signals to the other user equipment according to the time advance, in order that the signals transferred via downlink from network system, which are received by the other user equipment, are synchronized with the signals transferred via said direct link from said user equipment.

18. The user equipment according to claim 17, further includes:

a synchronization shift information receiving means, for receiving the synchronization shift information from said the other user equipment, which is the synchronization derivation estimated by the other user equipment after receiving P2P communication signals, according to the received P2P communication signals; and

a transmitting time adjusting means based on synchronization shift information, for adjusting the timing advance for transmitting signals to said the other user equipment according to said synchronization shift information.

19. The user equipment according to claim 17 or 18, further includes:

a feedback signals generating means, for calculating the difference between the time for receiving test signals and the time for receiving signals transmitted from network system, and sending the calculated difference as feedback signals to the other user equipment when receiving the test signals transmitted by the other user equipment, during the process of establishing said direct link.

20. The user equipment according to claim 19, further includes:

a synchronization shift information generating means, for estimating the synchronization shift information of the other user equipment according to the P2P communication signals when the UE receives P2P communication signals transmitted by said the other user equipment, and sending the estimated synchronization shift information to the other one.

21. A network system for supporting P2P communication between two user equipments in TDD CDMA systems, comprising:

a timeslot allocation information sending means for sending the timeslot allocation information to the two user equipments in P2P communication via downlink control channel;

a spreading code allocation information generating means for generating the spreading code allocation information corresponding to each downlink timeslot in the timeslot allocation information; and

a spreading code allocation information sending means for sending the spreading code allocation information to the two user equipments via downlink control channel respectively, so as to synchronize the P2P communication signals received by each of the two UEs with signals from network systems.

22. The network system according to claim 21, wherein said spreading codes allocation information at least contains the spreading code information being used by user equipments in said downlink timeslot.

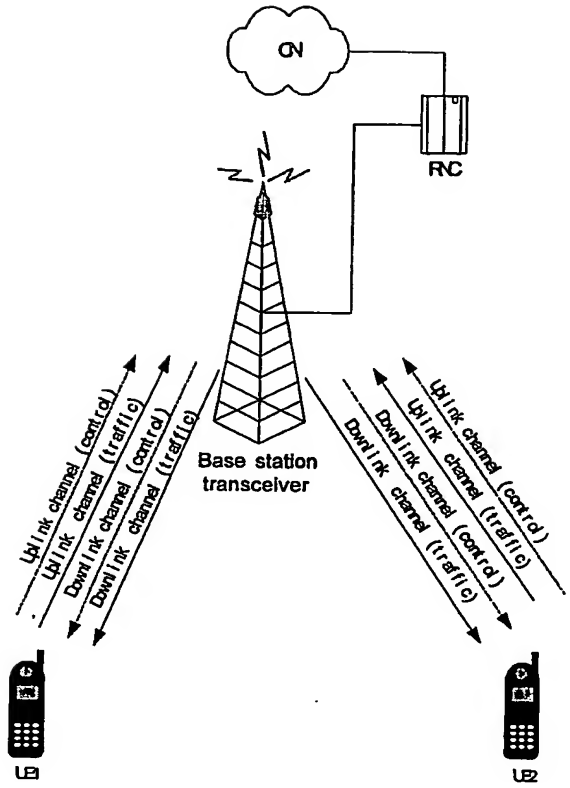
CN
RNC
Base station transceiver
Uplink channel (control)
Uplink channel (traffic)
Downlink channel (control)
Downlink channel (traffic)
Uplink channel (control)
Uplink channel (traffic)
Downlink channel (control)
Downlink channel (traffic)
UE1
UE2

Fig. 1

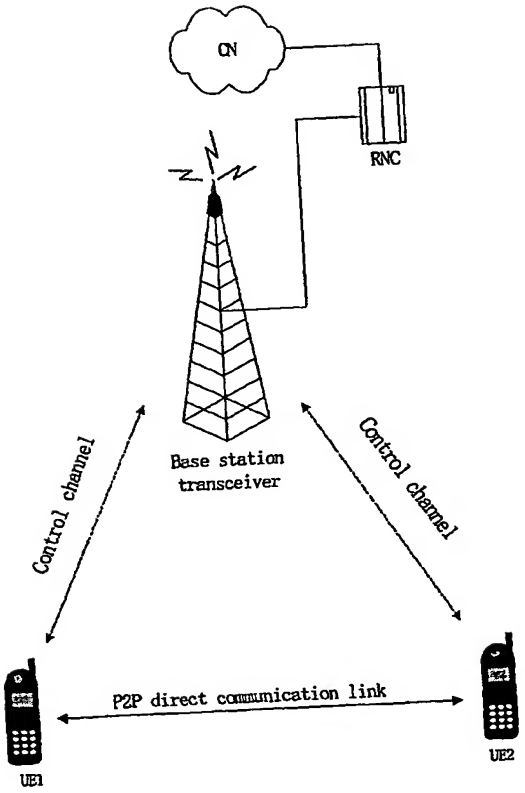
CN
RNC
Base station transceiver
Control channel
Control channel
P2P direct communication link
UE1
UE2

Fig. 2

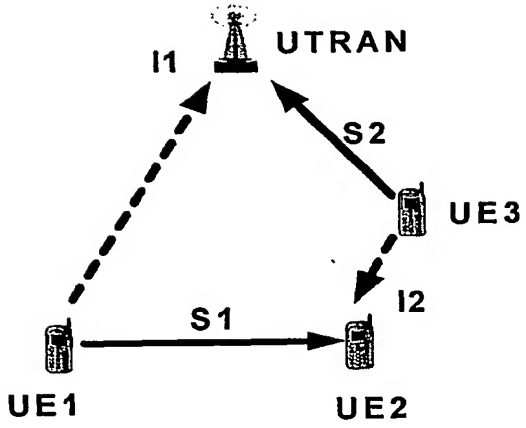

Fig. 3

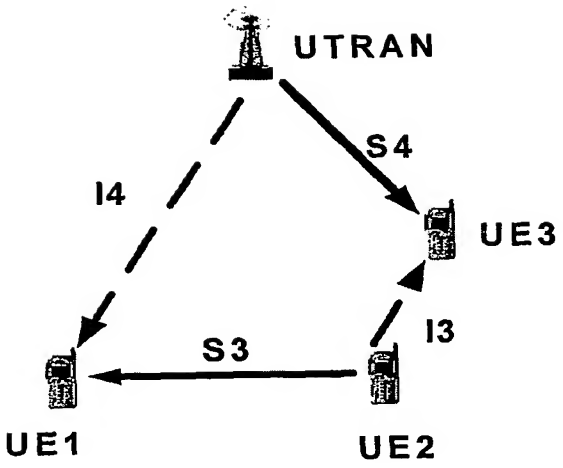

Fig. 4

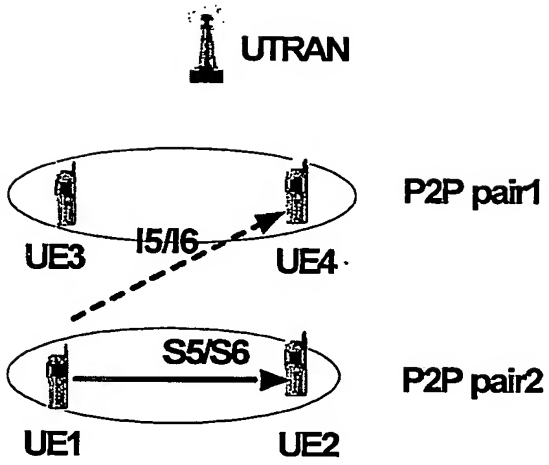

Fig. 5

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	TS0	TS1	TS2	TS3	TS4	TS5	TS6

Fig. 6

Fig. 7

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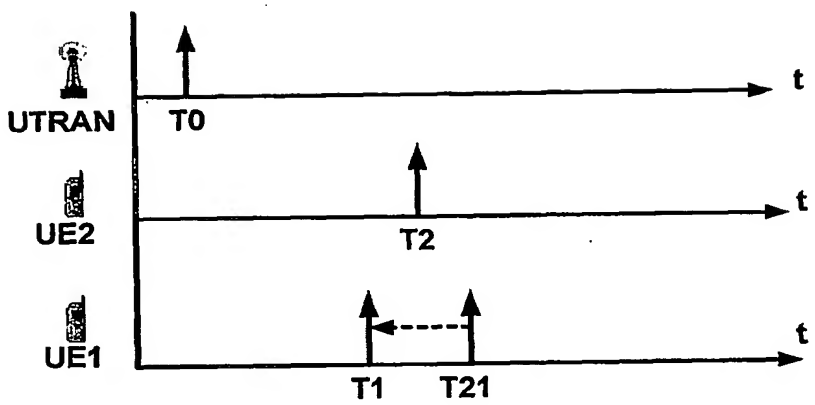

Fig. 8

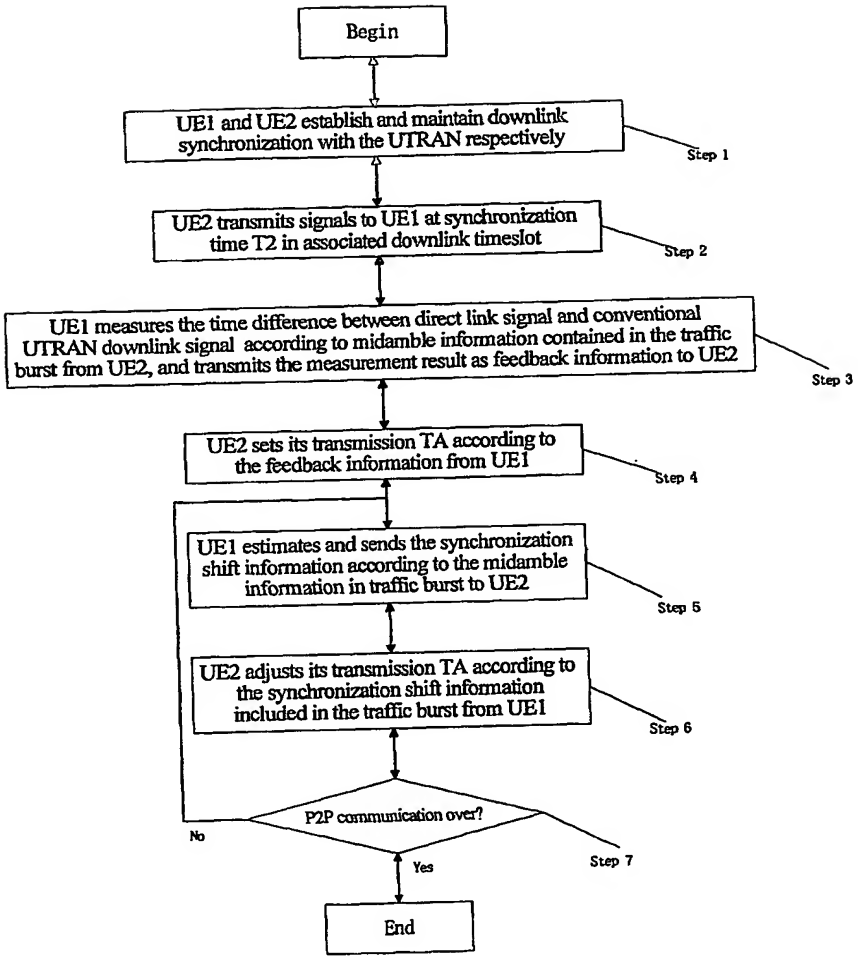
Begin
UE1 and UE2 establish and maintain downlink synchronization with the UTRAN respectively
Step 1
UE2 transmits signals to UE1 at synchronization time T2 in associated downlink timeslot
Step 2
UE1 measures the time difference between direct link signal and conventional UTRAN downlink signal according to midamble information contained in the traffic burst from UE2, and transmits the measurement result as feedback information to UE2
Step 3
UE2 sets its transmission TA according to the feedback information from UE1
Step 4
UE1 estimates and sends the synchronization shift information according to the midamble information in traffic burst to UE2
Step 5
UE2 adjusts its transmission TA according to the synchronization shift information included in the traffic burst from UE1
Step 6
P2P communication over?
No
Yes
Step 7
End

Fig. 9

INTERNATIONAL SEARCH REPORT

ational Application No
/IB2004/050354

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/36 H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5 995 844 A (FUKUDA KUNIO) 30 November 1999 (1999-11-30) abstract columns 1,4,6,8; figure 4	1,11

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 July 2004	28/07/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Englund, T

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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